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memorandum

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SUBJECT: Continuous-energy Neutron Data for Experiments relating to APT

Continuous-energy neutron data for Lu and Xe isotopes have been processed and QA'd for experiments relating to APT. The data were transferred to Dave Court, but are also available to Phil Ferguson on CFS under the directory */x6data/ce/special/endf61*. The two type 1 libraries are named *lu1* and *xe1* along with their corresponding files containing the xsdir entries *lu1.xs* and *xe1.xs* . Information for Appendix G of the MCNP manual is listed in Table 1. Each continuous-energy data library for MCNP has the following standard reaction cross-sections available; the total (MT=1), elastic (MT=2), total absorption/disappearance (MT=101), and total photon production (MT=202), as well as neutron heating information (MT=301). Figures 1-11 show the total and total absorption/disappearance cross sections for each nuclide in the *xe1* and *lu1* libraires. Note that none of these nuclides has photon production data available, and therefore the neutron heating information will include the energy that the photons would normally carry off. This may be significant for small target problems. Table 2 lists cross-section information available for other reactions for each nuclide in the libraries using the standard ENDF definitions.

Table 1: Appendix G Information for Lu and Xe isotopes

ZAID	AWR	Library	Temp	Total Length	Number of Energies	Max. Energy	GPD	Nubar
54124.61c	122.842	xe1	300	10050	1243	20	no	
54126.61c	124.823	xe1	300	10605	1367	20	no	
54128.61c	126.805	xe1	300	18268	2672	20	no	
54129.61c	127.797	xe1	300	73564	11762	20	no	
54130.61c	128.788	xe1	300	19353	2793	20	no	
54131.61c	129.781	xe1	300	48515	7613	20	no	
54132.61c	130.771	xe1	300	9024	1120	20	no	
54134.61c	132.755	xe1	300	6637	792	20	no	
54136.61c	134.740	xe1	300	4181	402	20	no	
71175.61c	173.438	lu1	300	22754	3180	20	no	
71176.61c	174.430	lu1	300	25676	3602	20	no	

Table 2: Reaction Data Available for Lu and Xe isotopes

ZAID	Reaction MT's Available
54124.61c	16, 17, 51, 52, 53, 54, 91, 102, 103, 104, 105, 106, 107
54126.61c	16, 17, 51, 52, 53, 54, 91, 102, 103, 104, 105, 106, 107
54128.61c	16, 17, 51, 52, 53, 91, 102, 103, 104, 105, 106, 107
54129.61c	16, 17, 51, 52, 53, 54, 55, 56, 91, 102, 103, 104, 105, 107
54130.61c	16, 17, 51, 52, 53, 54, 55, 56, 91, 102, 103, 104, 105, 107
54131.61c	16, 17, 51, 52, 53, 54, 55, 56, 91, 102, 103, 104, 105, 107
54132.61c	16, 17, 51, 52, 53, 54, 91, 102, 103, 104, 105, 107
54134.61c	16, 17, 51, 52, 53, 91, 102, 103, 104, 105, 107
54136.61c	16, 17, 51, 52, 53, 91, 102, 103, 104, 105, 107
71175.61c	16, 17, 51, 52, 53, 54, 55, 56, 57, 58, 91 102, 103, 107
71176.61c	16, 17, 51, 52, 53, 54, 55, 56, 57, 58, 91 102, 103, 107

Production and QA of Continuous-energy Data

In addition to examining the NJOY output files for problems detected during the processing of the data, a number of additional checks of the data are performed. All of the additional checking codes operate on a Type 1 (ASCII) data library containing an arbitrary number of individual data files. Some of these additional checks are described here, while others were not pertinent to this particular set of data as for photon production data or total charged particle production data (MT=203-207).

The code CHECKND_NEUT.F analyzed various aspects of secondary neutron energy distributions using LAW=4 or LAW=44. The code verifies that interpolation schemes 1 or 2 are used, and identifies any negative probability density functions if found. The code checks to see if any secondary neutrons can be produced with energies greater than the energy of the incident neutron (for fission the code takes no corrective action). The code will actually fix two specific types of problems, 1) it changes negative probability density functions to zero and 2) it corrects for secondary neutron energies greater than incident where appropriate and renormalizes. It then creates a new data library if any modifications have been made.

The code CHECKTHRESH.F compares threshold energies with kinematic thresholds for negative Q-value reactions. The code calculates the kinematic threshold as

$$\text{K.T.} = \frac{-Q*(\text{AWR}+1)}{\text{AWR}} \quad ,$$

where AWR is the atomic weight ratio and Q is the Q-value. If the actual threshold on the library is lower than the kinematic threshold, the code outputs this information along with the magnitude of the discrepancy, the law specified for the secondary neutrons, and the line number on the type 1 library containing the problem energy value. Currently, while incorrect values for the thresholds may exist, MCNP will only experience a fatal error for distributions using LAW=3. The code also identifies the largest threshold error detected. While NJOY does check the thresholds of the reactions, CHECKTHRESH.F provides more diagnostic information for correcting any problems.

In addition to running the various QA codes, plots of all cross sections are made and examined for reasonableness. Comparisons with data available from other sources may be made, or if questions arise concerning the processing of data from resonance parameters, comparison with data generated by SAMMY can also be made (this is usually only used for multitemperature data). Reasonableness can include things such as verifying that no problems exist from the specification of single-level Breit-Wigner parameters, no negative heating numbers are present, the data reflects known experimental data, etc. In this case, evaluations are also available for Xe-133 and Xe-135. These data were not provided on this library due to the overly simplistic nature of the evaluation as illustrated in Figures 12 and 13. While, Xe-136 data is also fairly simplistic it comprises 8.9% of natural Xe and was included in the library.

Figure 1: Total & Absorption Cross Section Xe–124

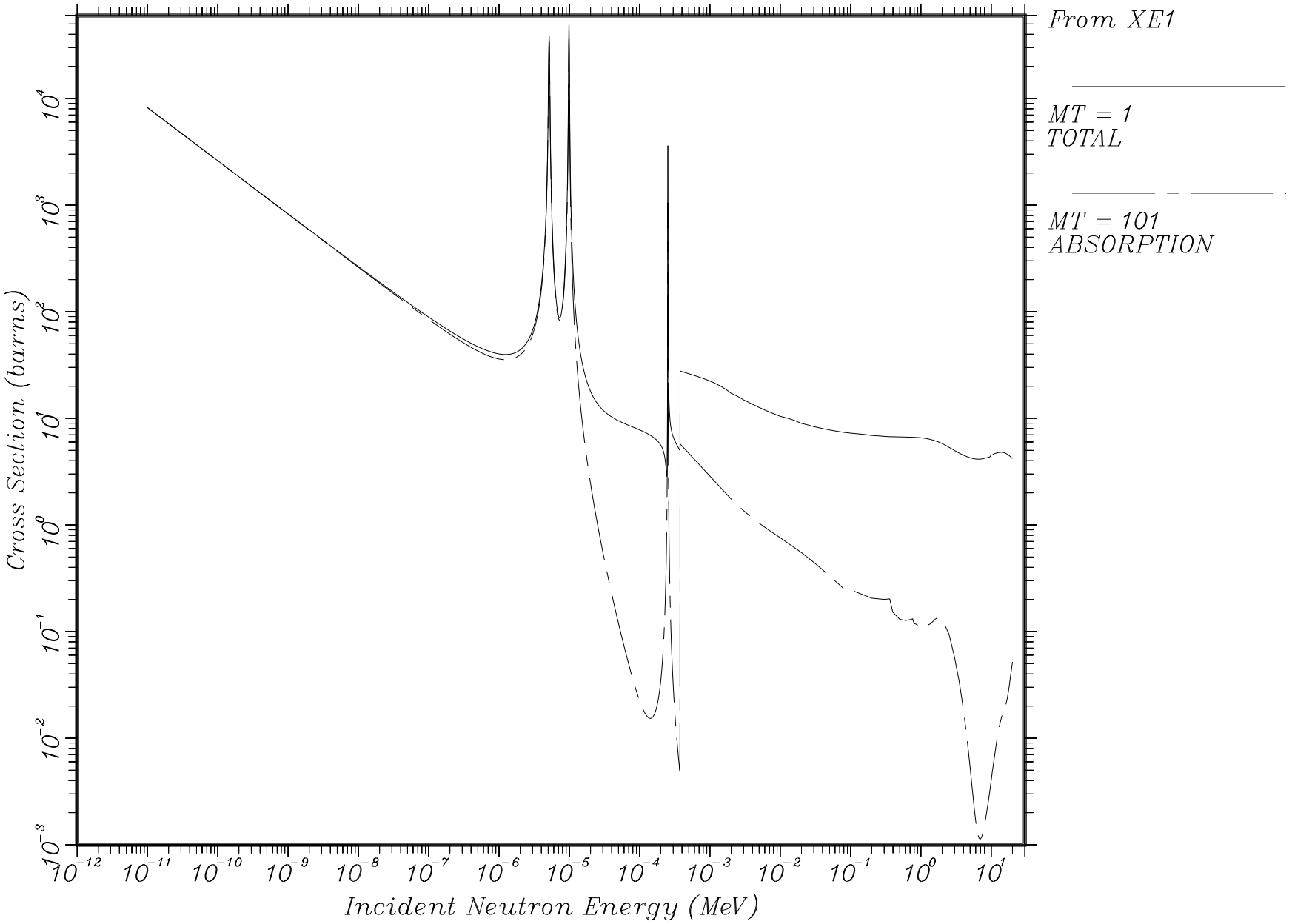

Figure 2: Total & Absorption Cross Section Xe–126

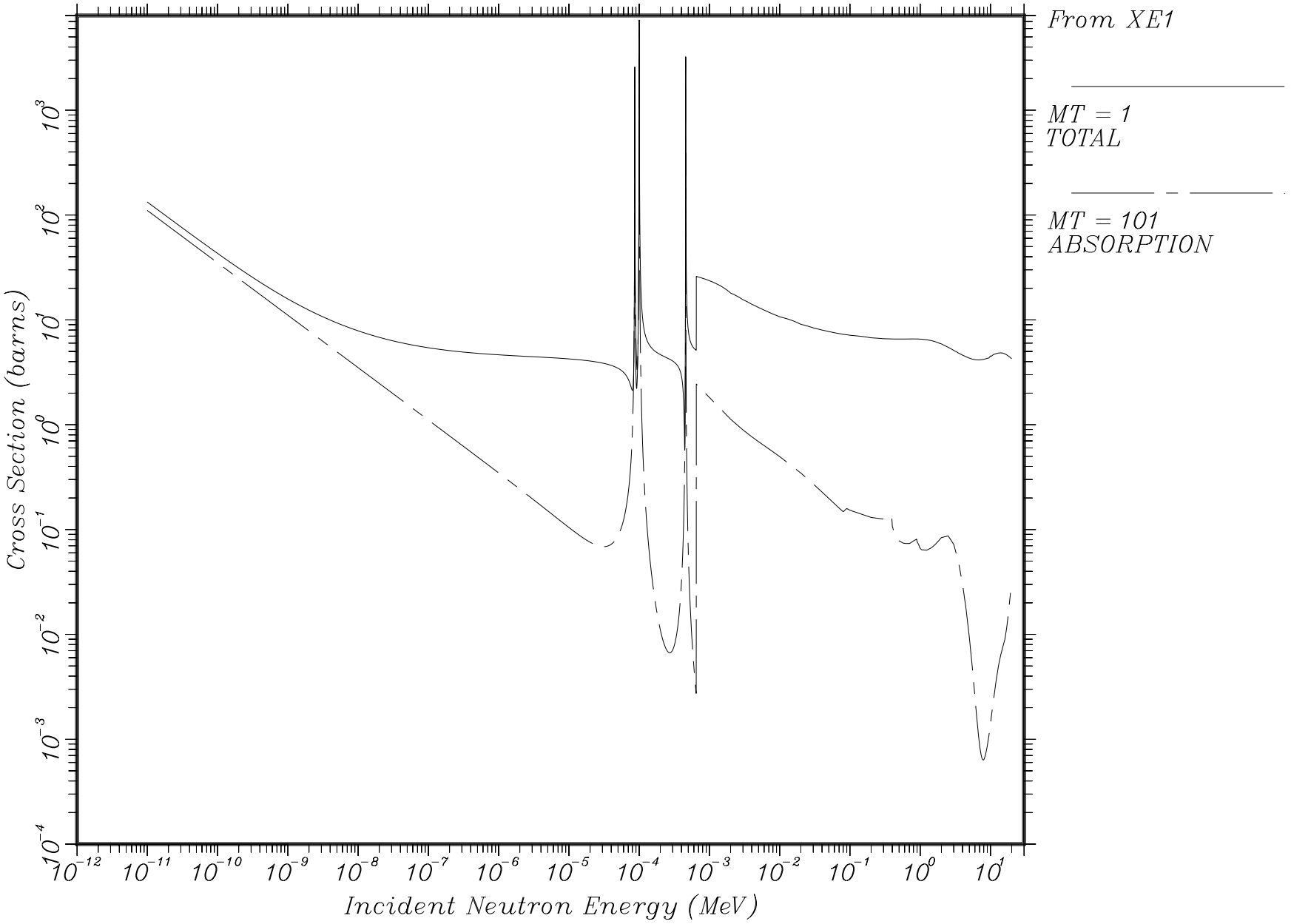

Figure 3: Total & Absorption Cross Section Xe–128

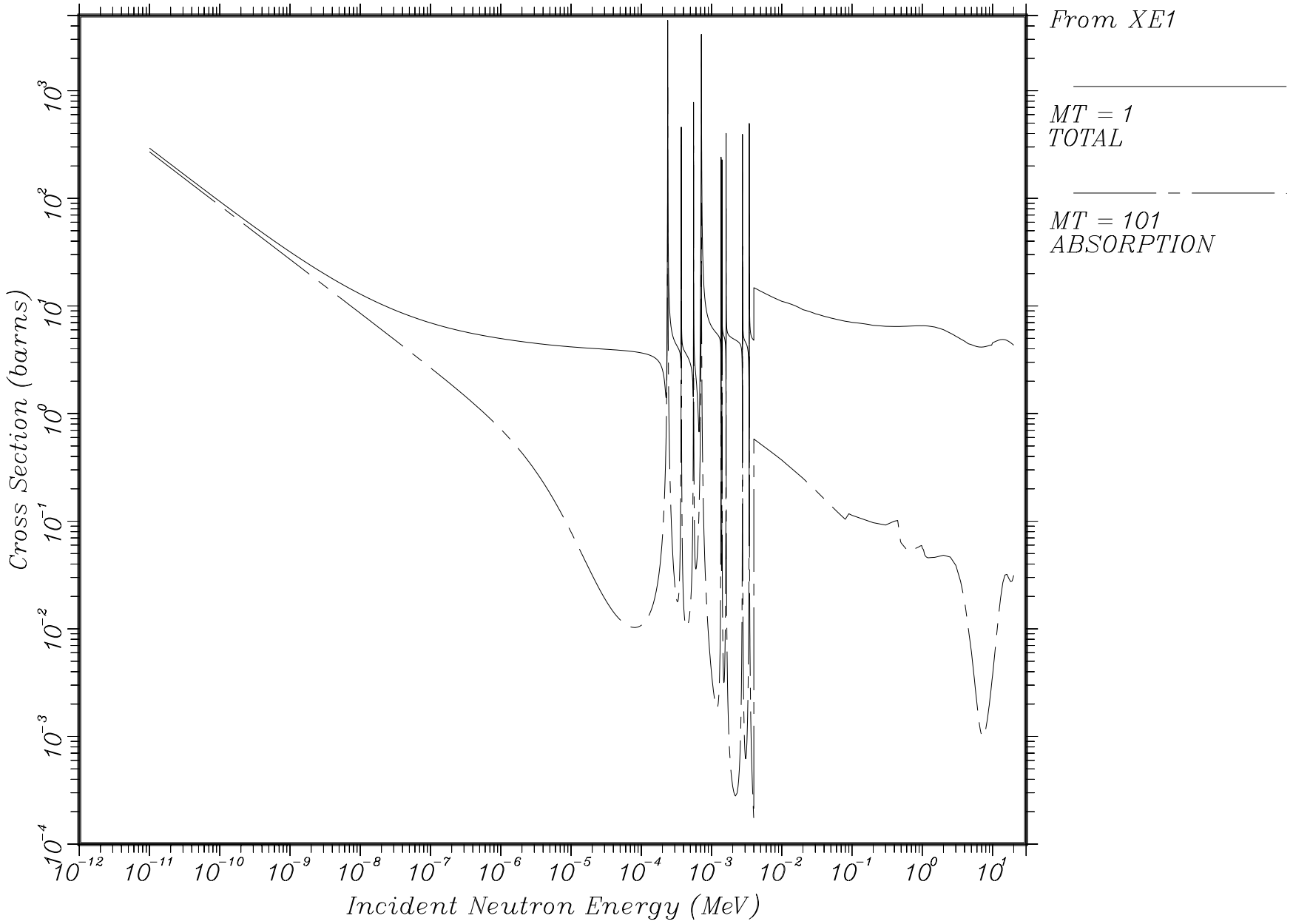

Figure 4: Total & Absorption Cross Section Xe–129

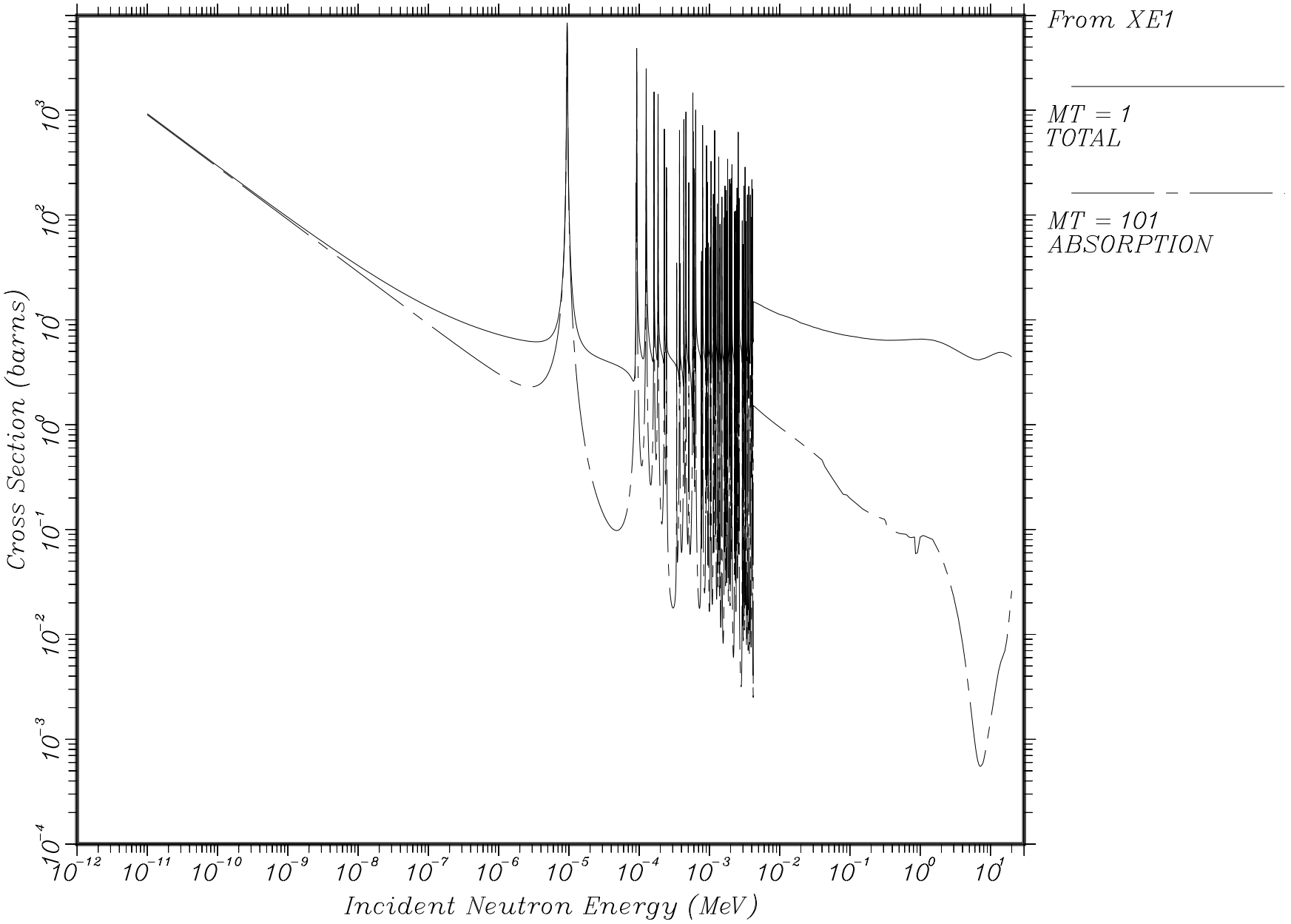

Figure 5: Total & Absorption Cross Section Xe–130

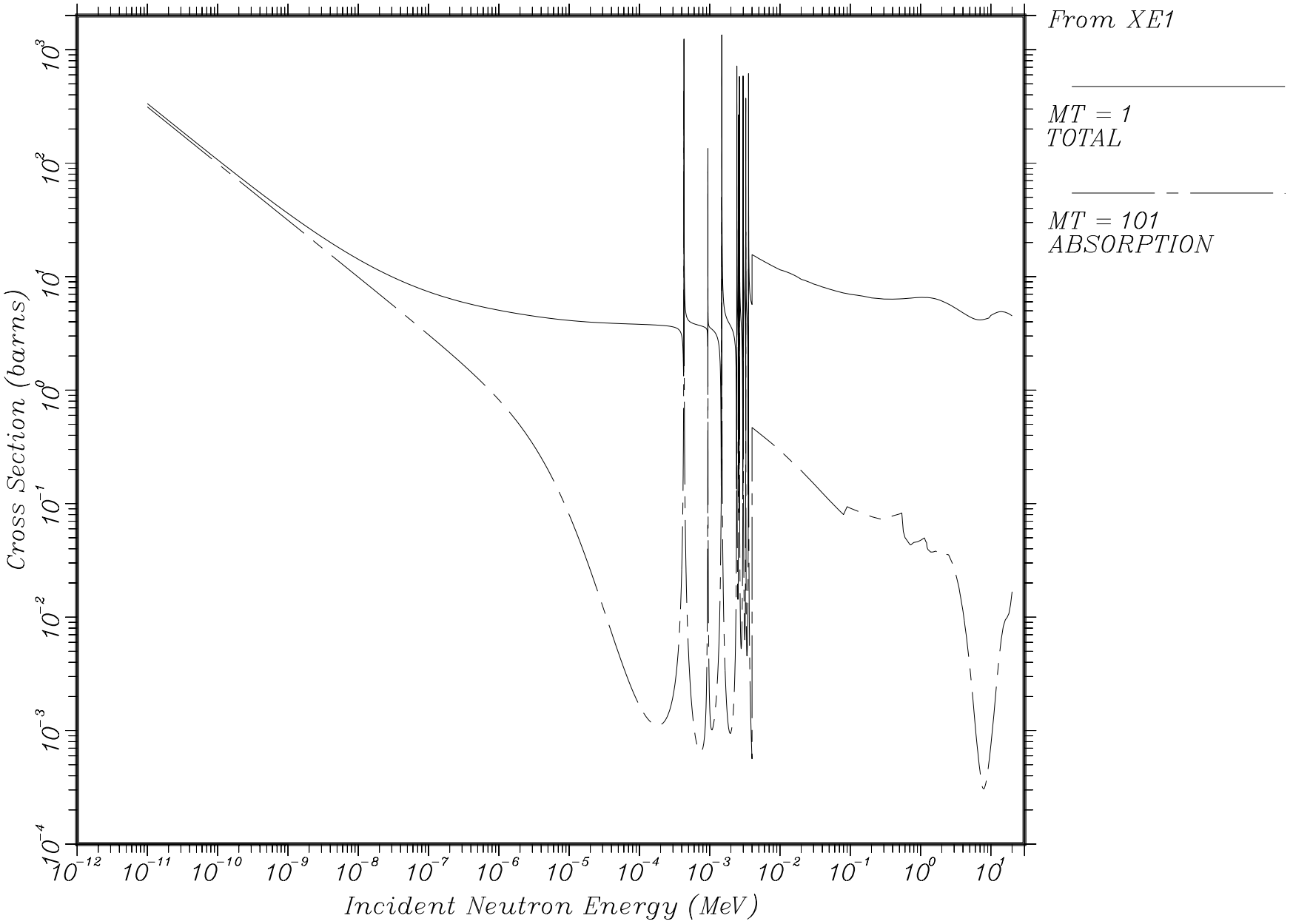

Figure 6: Total & Absorption Cross Section Xe–131

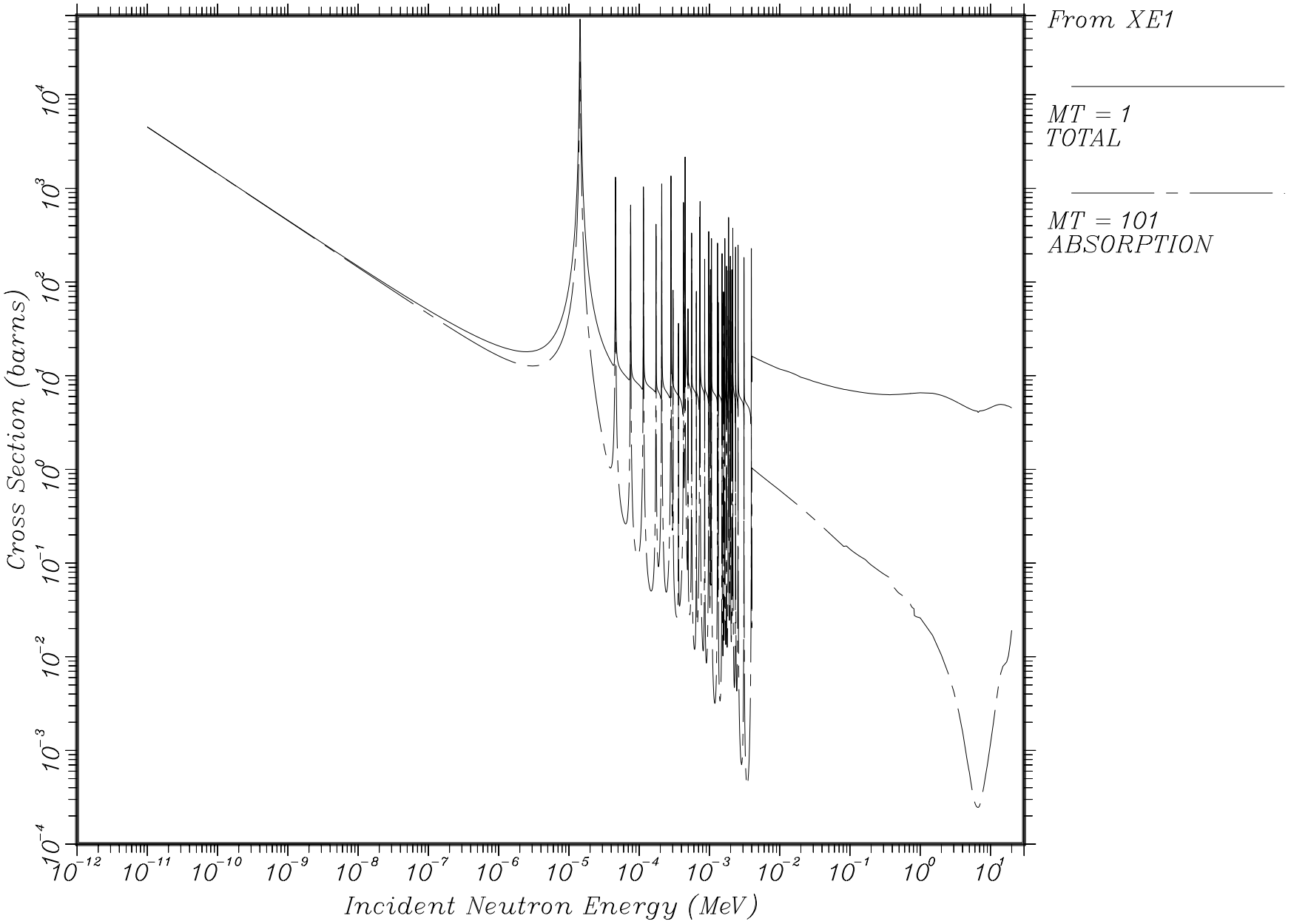

Figure 7: Total & Absorption Cross Section Xe–132

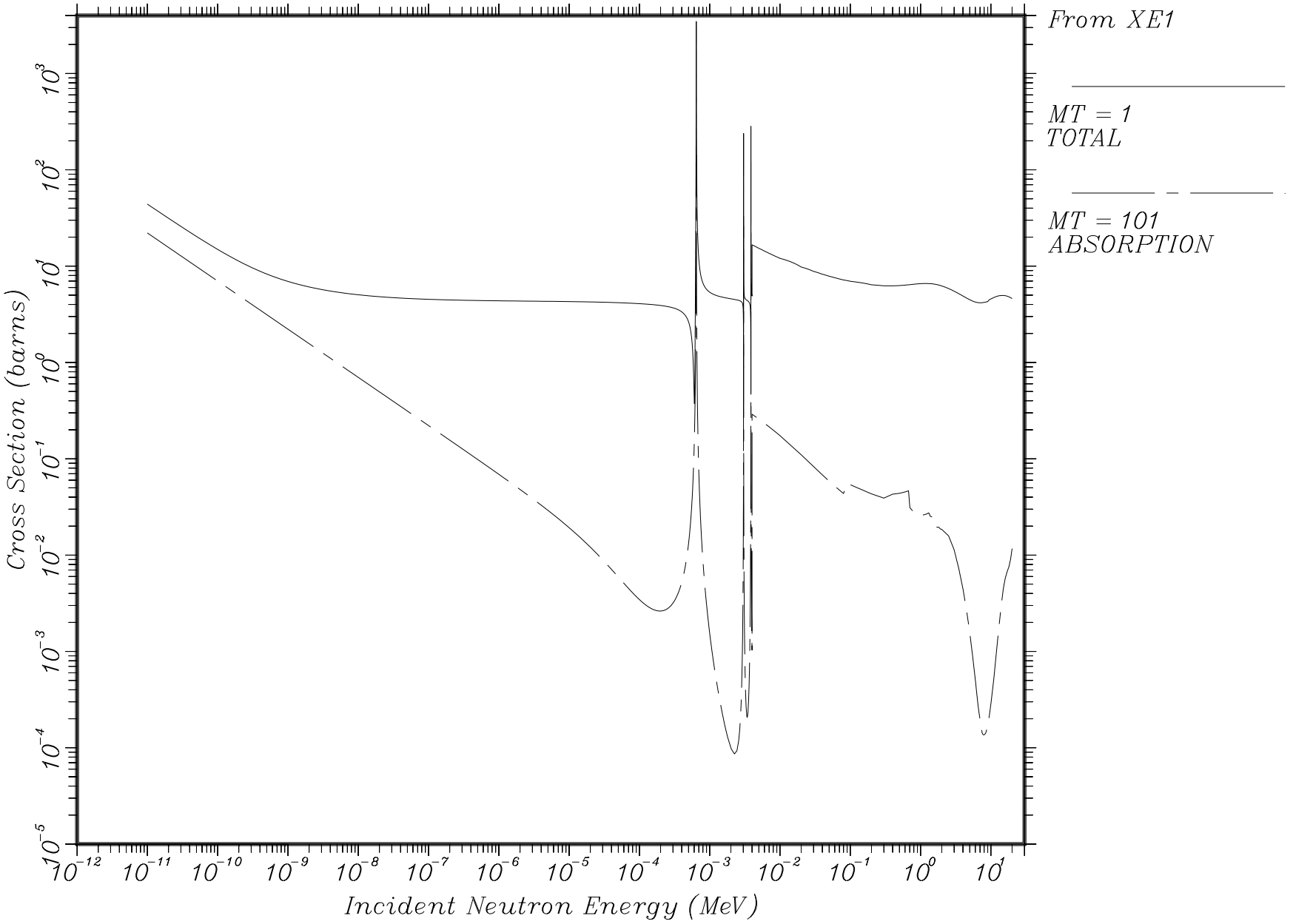

Figure 8: Total & Absorption Cross Section Xe–134

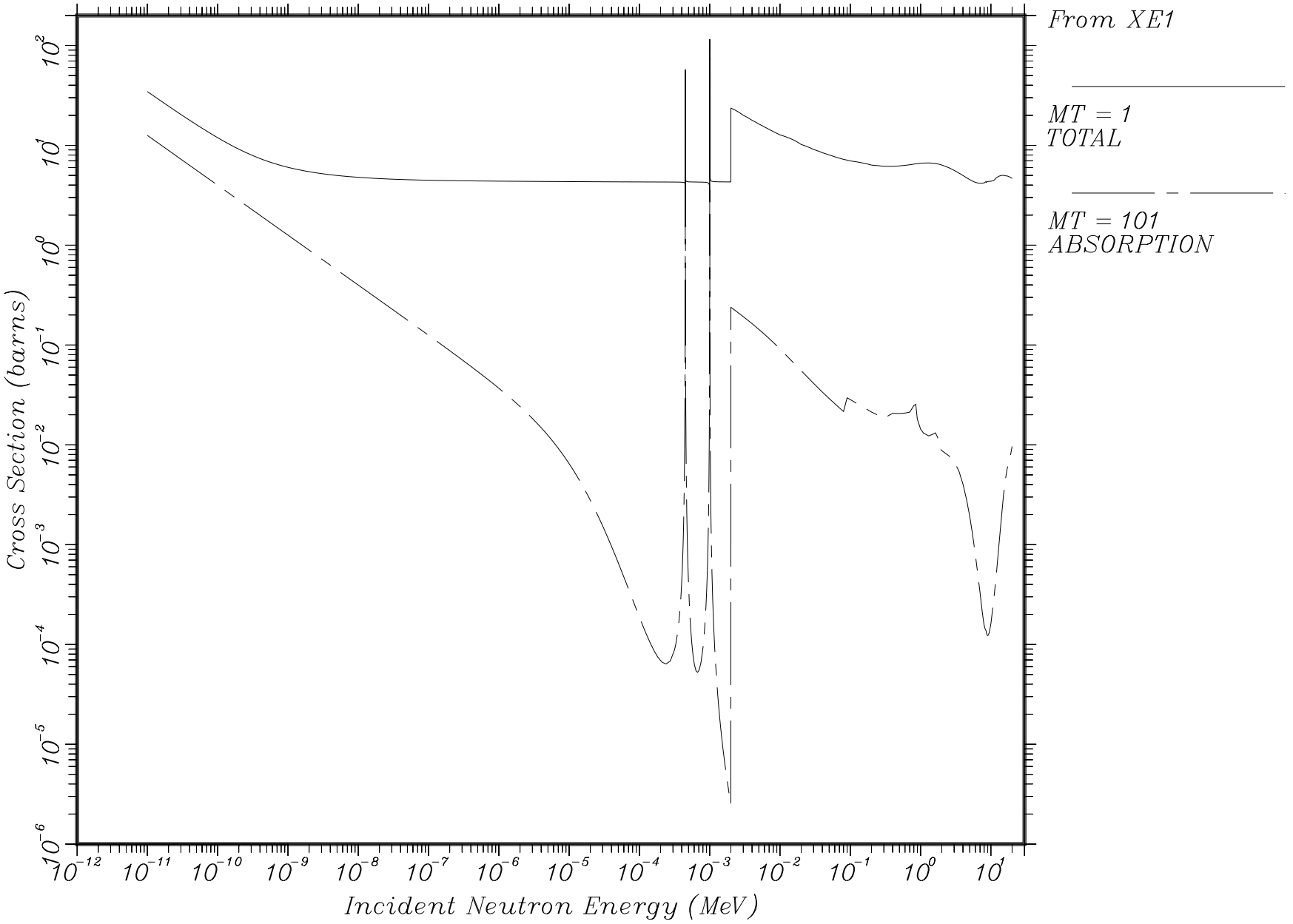

Figure 9: Total & Absorption Cross Section Xe–136

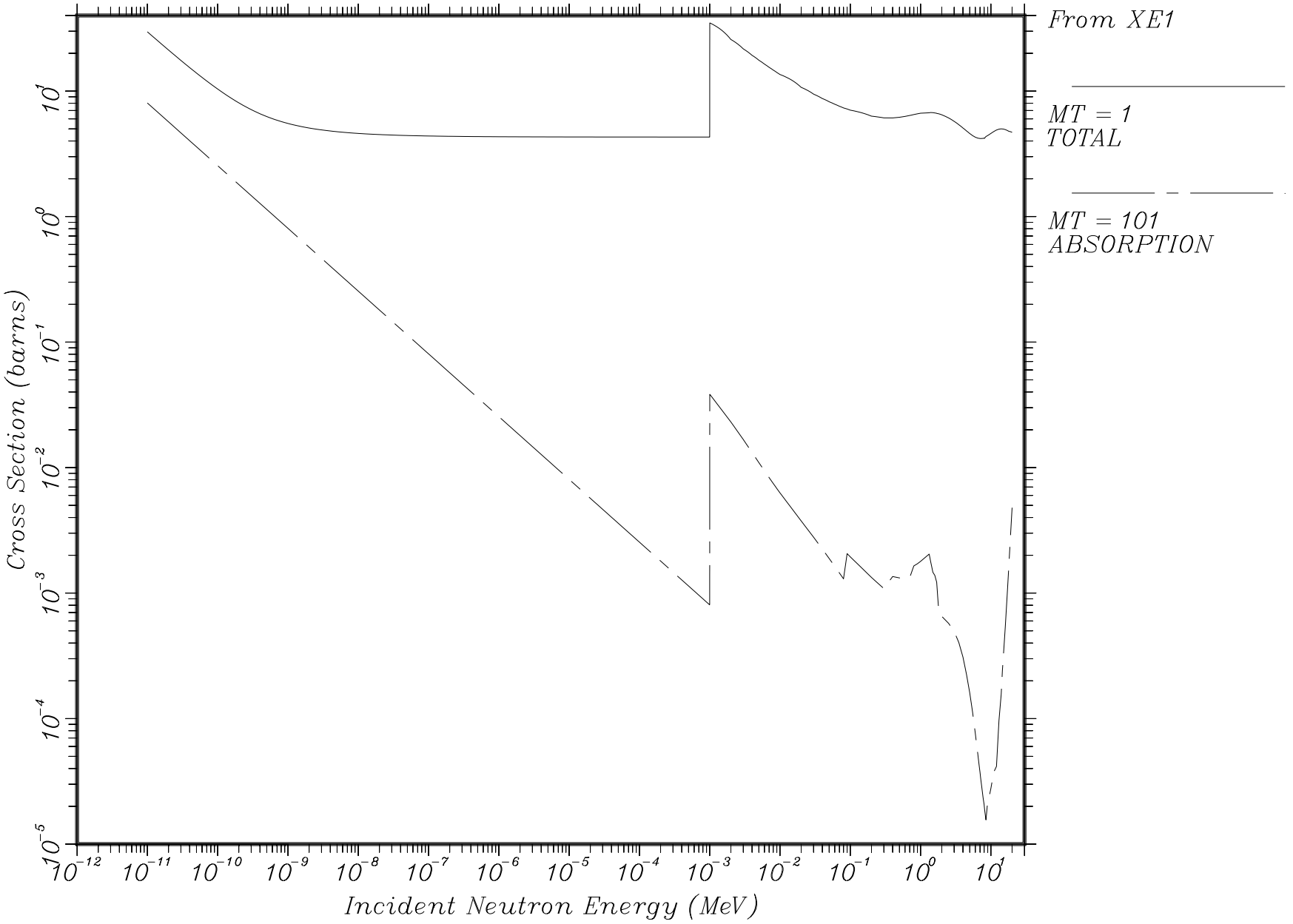

Figure 10: Total & Absorption Cross Section Lu–175

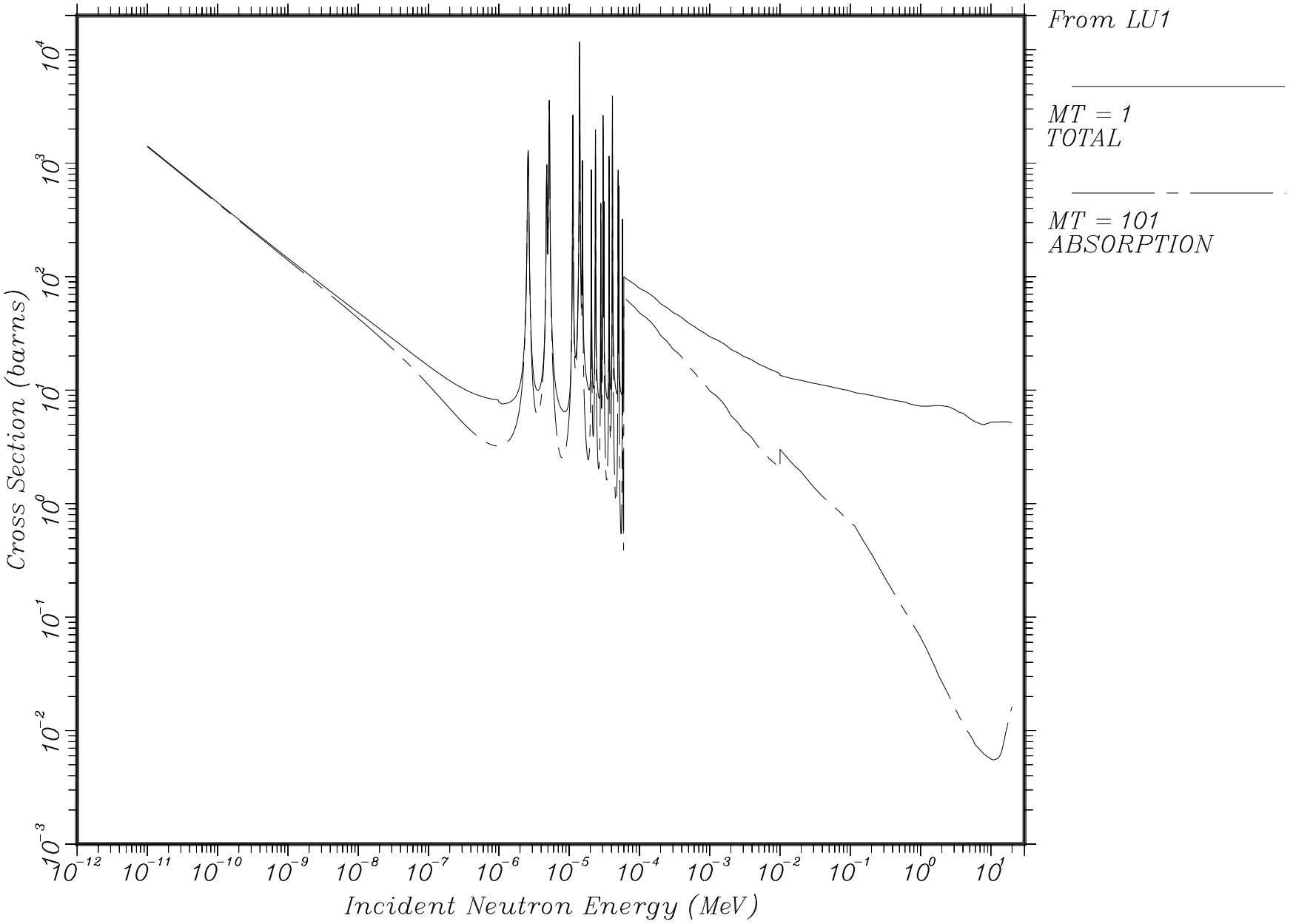

Figure 11: Total & Absorption Cross Section Lu–176

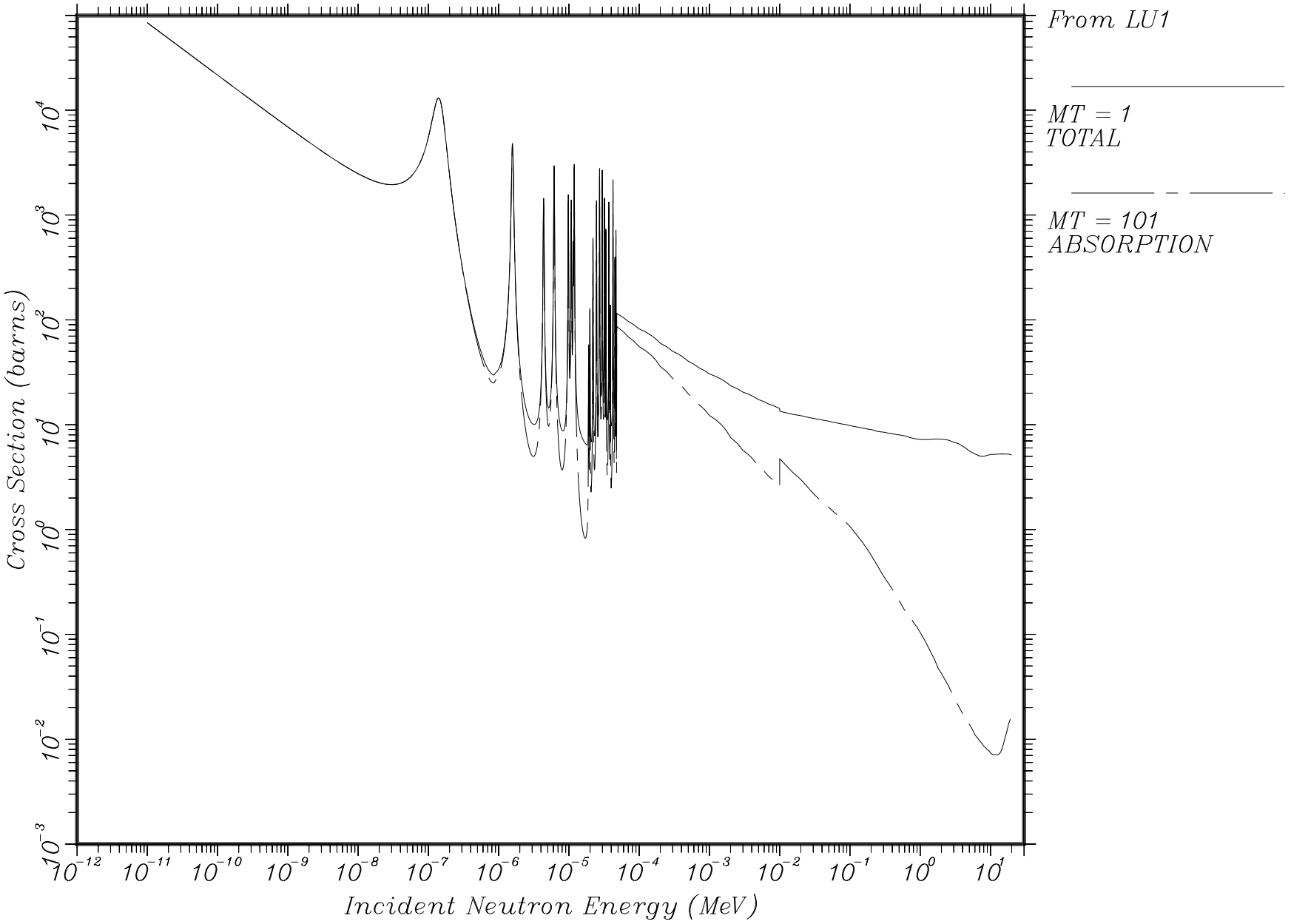

Figure 12: Total & Absorption Cross Section Xe–133

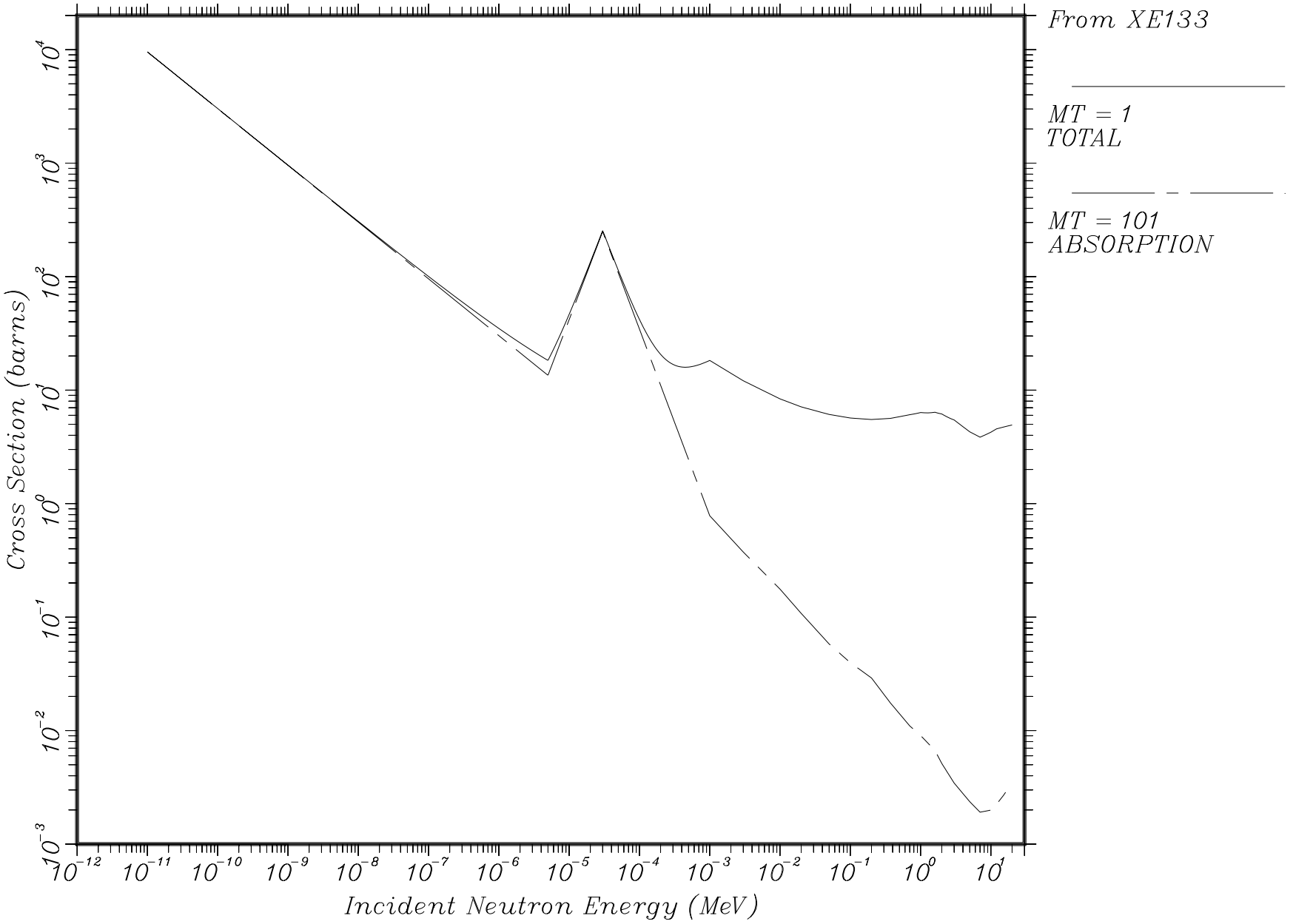

Figure 13: Total & Absorption Cross Section Xe–135